Section 1.
Introduction to the
National Electrical Safety Code®

010. Purpose

The purpose of these rules is the practical safeguarding of persons during the installation, operation, or maintenance of electric supply and communication lines and associated equipment.

These rules contain the basic provisions that are considered necessary for the safety of employees and the public under the specified conditions. This code is not intended as a design specification or as an instruction manual.

011. Scope

These rules cover supply and communication lines, equipment, and associated work practices employed by a public or private electric supply, communications, railway, or similar utility in the exercise of its function as a utility. They cover similar systems under the control of qualified persons, such as those associated with an industrial complex or utility interactive system.

NESC® rules do not cover installations in mines, ships, railway rolling equipment, aircraft, or automotive equipment, or utilization wiring except as covered in Parts 1 and 3. For building utilization wiring requirements, see the National Electrical Code® (NEC®), NFPA 70-1993.[1]

012. General Rules

A. All electric supply and communication lines and equipment shall be designed, constructed, operated, and maintained to meet the requirements of these rules.

B. The utilities, authorized contractors, or other entities, as applicable, performing design, construction, operation, or maintenance tasks for electric supply or communication lines or equipment covered by this code shall be responsible for meeting applicable requirements.

C. For all particulars not specified in these rules, construction and maintenance should be done in accordance with accepted good practice for the given local conditions known at the time by those responsible for the construction or maintenance of the communication or supply lines and equipment.

013. Application

A. New Installations and Extensions

1. These rules shall apply to all new installations and extensions, except that they may be waived or modified by the administrative authority. When so waived or modified, safety shall be provided in other ways.

   EXAMPLE: Alternative working methods, such as the use of barricades, guards, or other electrical protective equipment, may be implemented along with appropriate alternative working clearances as a means of providing safety when working near energized conductors.

2. Types of construction and methods of installation other than those specified in the rules may be used experimentally to obtain information, if done where qualified supervision is provided.

B. Existing Installations

1. Where an existing installation meets, or is altered to meet, these rules, such installation is considered to be in compliance with this edition and is not required to comply with any previous edition.
2. Existing installations, including maintenance replacements, that currently comply with prior editions of the Code, need not be modified to comply with these rules except as may be required for safety reasons by the administrative authority.

[1] Information on references can be found in Section 3.

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Accredited Standards Committee C2-1997

National Electrical Safety Code®

Secretariat

Institute of Electrical and Electronics Engineers, Inc.

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American National Standards Institute

1997 Edition

Abstract: This standard covers basic provisions for safeguarding of persons from hazards arising from the installation, operation, or maintenance of 1) conductors and equipment in electric supply stations, and 2) overhead and underground electric supply and communication lines. It also includes work rules for the construction, maintenance, and operation of electric supply and communication lines and equipment.

The standard is applicable to the systems and equipment operated by utilities, or similar systems and equipment, of an industrial establishment or complex under the control of qualified persons.

This standard consists of the introduction, definitions, grounding rules, list of referenced and bibliographic documents, and Parts 1, 2, 3, and 4 of the 1997 Edition of the National Electrical Safety Code.

Keywords: communications industry safety; construction of communication lines; construction of electric supply lines; electric supply stations, electric utility stations; electrical safety; high-voltage safety; operation of communications systems; operation of electric supply systems; power station equipment; power station safety; public utility safety; safety work rules; underground communication line safety; underground electric line safety

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condominium arrangements, or through other arrangements such as one where the telephone company and power company each own every other pole. Cable companies have commonly leased a portion of the pole space available for low voltage applications from either the telephone company or the power company. Methods of setting purchase prices and of calculating pole attachment rates generally are prescribed by federal and state regulatory authorities.

The number of parties wishing to participate in pole sharing arrangements should only increase with the advent of competition in local telecommunications markets. Economic and institutional factors strongly support reliance on pole sharing arrangements. It makes economic sense for power companies, cable companies and telephone companies to share pole space because they are all serving the same customer. Moreover, most local authorities restrict sharply the number of poles that can be placed on any particular right-of-way, thus rendering pole space a scarce resource. The Federal Telecommunications Act reinforces and regulates the market for pole space by prescribing nondiscriminatory access to poles (as well as to conduit and other rights-of-way) for any service provider that seeks access. The aerial distribution share factors displayed below capture a forward-looking view of the importance of these arrangements in an increasingly competitive local market.

B.2. Structure Sharing Parameters

The Hatfield Model captures the effects of structure sharing arrangements through the use of user-adjustable structure sharing parameters. These define the fraction of total required investment that will be borne by the LEC for distribution and feeder poles, and for trenching used as structure to support buried and underground telephone cables. Since best forward looking practice indicates that structure will be shared among LECs, IXCs, CAPs, cable companies, and other utilities, default structure sharing parameters are assumed to be less than one. Incumbent telephone companies, then, should be expected to bear only a portion of the forward-looking costs of placing structure, with the remainder to be assumed by other users of this structure.

The default LEC structure share percentages displayed below reflect most likely, technically feasible structure sharing arrangements. For both distribution and feeder facilities, structure share percentages vary by facility type to reflect differences in the degree to which structure associated with aerial, buried or underground facilities can reasonably be shared. Structure share parameters for aerial and underground facilities also vary by density zone to reflect the presence of more extensive sharing opportunities in urban and suburban areas. In addition, LEC shares of buried feeder structure are larger than buried distribution structure shares because a LEC's ability to share buried feeder structure with power companies is less over the relatively longer routes that differentiate feeder runs from distribution runs. This is because power companies generally do not share trenches with telephone facilities over distances exceeding 2500 ft.[58]

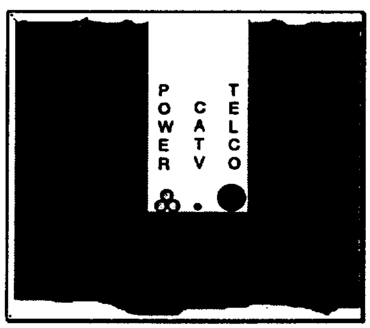
[58] A LEC's sharing of trenches with power companies, using random separation between cables for distances greater than 2,500 feet requires that either the telecommunications cable have no metallic components (i.e., fiber cable), or that both companies follow "Multi-Grounded Neutral" practices (use the same connection to earth ground at least every 2,500 feet).

Buried Facilities:

Buried structure sharing practices are more difficult to observe directly than pole sharing practices. Some insight into the degree to which buried structure is, and will be shared can be gained from prevailing municipal rules and architectural conventions governing placement of buried facilities. As mentioned in the overview, municipalities generally regulate subsurface construction. Their objectives are clear: less damage to other subsurface utilities, less cost to ratepayers, less disruption of traffic and property owners, and fewer instances of deteriorated roadways from frequent excavation and potholes.

Furthermore, since 1980, new subdivisions have usually been served with buried cable for several reasons. First, prior to 1980, cables filled with water blocking compounds had not been perfected. Thus, prior to that time, buried cable was relatively expensive and unreliable. Second, reliable splice closures of the type required for buried facilities were not the norm. And third, the public now clearly desires more out-of-sight plant for both aesthetic and safety related reasons. Contacts with telephone outside plant engineers, architects and property developers in several states confirm that in new subdivisions, builders typically not only prefer buried plant that is capable of accommodating multiple uses, but they usually dig the trenches at their own expense, and place power, telephone, and CATV cables in the trenches, if the utilities are willing to supply the materials. Thus, many buried structures are available to the LEC at no charge. The effect of such "no charge" use of developer-dug trenches reduces greatly the effective portion of total buried structure cost borne by the LEC. Note, too, that because power companies do not need to use a disproportionately large fraction of a trench – in contrast to their disproportionate use of pole space, and because certain buried telephone cables are plowed into the soil rather than placed in trenches, the HM 5.0 assumed LEC share of buried structure generally is greater than of aerial structure.

Facilities are easily placed next to each other in a trench as shown below:



Underground Facilities:

Underground plant is generally used in more dense areas, where the high cost of pavement restoration makes it attractive to place conduit in the ground to permit subsequent cable reinforcement or replacement, without the need for further excavation. Underground conduit usually is the most expensive investment per foot of structure -- with most of these costs attributable to trenching. For this reason alone, it is the most attractive for sharing.

In recent years, major cities such as New York, Boston, and Chicago have seen a large influx of conduit occupants other than the local telco. Indeed most of the new installations being performed today are cable placement for new telecommunications providers. As an example, well over 30 telecommunications

APPENDIX B

Structure Shares Assigned to Incumbent Local Telephone Companies

B.1. Overview

Due to their legacy as rate-of-return regulated monopolies, LECs and other utilities have heretofore had little incentive to share their outside plant structure with other users. To share would have simply reduced the "ratebase" upon which their regulated returns were computed. But today and going forward, LECs and other utilities face far stronger economic and institutional incentives to share outside plant structure whenever it is technically feasible. There are two main reasons. First, because utilities are now more likely to either face competition or to be regulated on the basis of their prices (e.g., price caps) rather than their costs (e.g., ratebase), a LEC's own economic incentive is to share use of its investment in outside plant structure. Such arrangements permit the LEC to save substantially on its outside plant costs by spreading these costs across other utilities or users. Second, many localities now strongly encourage joint pole usage or trenching operations for conduit and buried facilities as a means of minimizing the unsightliness and/or right-of-way congestion occasioned by multiple poles, or disruptions associated with multiple trenching activities.

Because of these economic and legal incentives, not only has structure sharing recently become more common, but its incidence is likely to accelerate in the future – especially given the Federal Telecommunications Act's requirements for nondiscriminatory access to structure at economic prices.

The degree to which a LEC can benefit from structure sharing arrangements varies with the type of facility under consideration. Sharing opportunities are most limited for multiple use of the actual conduits (e.g., PVC pipe) through which cables are pulled that comprise a portion of underground structure. Because of safety concerns, excess ILEC capacity within a conduit that carries telephone cables can generally be shared only with other low-voltage users, such as cable companies, other telecommunications companies, or with municipalities or private network operators. Although the introduction of fiber optic technology has resulted in slimmer cables that have freed up extra space within existing conduits, and thus enlarged actual sharing opportunities, the Hatfield Model does not assume that conduit is shared because as a forward-looking model of efficient supply, it assumes that a LEC will not overbuild its conduit so as to carry excess capacity available for sharing.

Trenching costs of conduit, however, account for most of the costs associated with underground facilities – and LECs can readily share these costs with other telecommunications companies, cable companies, electric, gas or water utilities, particularly when new construction is involved. Increased CATV penetration rates and accelerated facilities based entry by CLECs into local telecommunications markets will expand further future opportunities for underground structure sharing. In addition, in high density urban areas, use of existing underground conduit is a much more economic alternative than excavating established streets and other paved areas.

Sharing of trenches used for buried cable is already the norm, especially in new housing subdivisions. In the typical case, power companies, cable companies and LECs simply place their facilities in a common trench, and share equally in the costs of trenching, backfilling and surface repair. Gas, water and sewer companies may also occupy the trench in some localities. Economic and regulatory factors are likely to increase further incentives for LECs to schedule and perform joint trenching operations in an efficient manner.

Aerial facilities offer the most extensive opportunities for sharing. The practice of sharing poles through joint ownership or monthly lease arrangements is already widespread. Indeed, the typical pole carries the facilities of at least three potential users – power companies, telephone companies and cable companies. Power companies and LECs typically share the ownership of poles through either cross-lease or

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Section 32.
Underground Conduit Systems

NOTE: While it is often the practice to use *duct* and *conduit* interchangeably, *duct*, as used herein, is a single enclosed raceway for conductors or cable; *conduit* is a structure containing one or more ducts; and *conduit system* is the combination of conduit, conduits, manholes, handholes, and/or vaults joined to form an integrated whole.

320. Location

A. Routing

1. General

   a. Conduit systems should be subject to the least disturbance practical. Conduit systems extending parallel to other subsurface structures should not be located directly over or under other subsurface structures. If this is not practical, the rule on separation, as stated in Rule 320B, should be followed.

   b. Conduit alignment should be such that there are no protrusions that would be harmful to the cable.

   c. Where bends are required, the bending radius shall be sufficiently large to limit the likelihood of damage to cable being installed in the conduit.

   RECOMMENDATION: The maximum change of direction in any plane between lengths of straight rigid conduit without the use of bends should be limited to 5 degrees.

2. Natural Hazards

   Routes through unstable soils such as mud, shifting soil, etc., or through highly corrosive soils, should be avoided. If construction is required in these soils, the conduit should be constructed in such a manner as to minimize movement or corrosion or both.

3. Highways and Streets

   When conduit must be installed longitudinally under the roadway, it should be installed in the shoulder or, to the extent practical, within the limits of one lane of traffic.

4. Bridges and Tunnels

   The conduit system shall be located so as to limit the likelihood of damage by traffic. It should be located to provide safe access for inspection or maintenance of both the structure and the conduit system.

5. Crossing Railroad Tracks

   a. The top of the conduit system should be located not less than 900 mm (36 in) below the top of the rails of a street railway or 1.27 m (50 in) below the top of the rails of a railroad. Where unusual conditions exist or where proposed construction would interfere with existing installations, a greater depth than specified above may be required.

   EXCEPTION: Where this is impractical, or for other reasons, this separation may be reduced by agreement between the parties concerned. In no case, however, shall the top of the conduit or any conduit protection extend higher than the bottom of the ballast section that is subject to working or cleaning.

   b. At crossings under railroads, manholes, handholes, and vaults should not, where practical, be located in the roadbed.

6. Submarine Crossing

   Submarine crossings should be routed, installed, or both so they will be protected from erosion by tidal action or currents. They should not be located where ships normally anchor.

B. Separation From Other Underground Installations

1. General

   The separation between a conduit system and other underground structures paralleling it should be as large as necessary to permit maintenance of the system without damage to the paralleling structures. A conduit that crosses over another subsurface structure shall have a separation suffi-

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cient to limit the likelihood of damage to either structure. These separations should be determined by the parties involved.

EXCEPTION: When conduit crosses a manhole, vault, or subway tunnel roof, it may be supported directly on the roof with the concurrence of all parties involved.

2. Separations Between Supply and Communication Conduit Systems USE AT·T SHRUCT SHAR %

   Conduit systems to be occupied by communication conductors shall be separated from conduit systems to be used for supply systems by

   a. 75 mm (3 in) of concrete
   b. 100 mm (4 in) of masonry
   c. 300 mm (12 in) of well-tamped earth

   EXCEPTION: Lesser separations may be used where the parties concur.

3. Sewers, Sanitary and Storm

   a. If conditions require a conduit to be installed parallel to and directly over a sanitary or storm sewer, it may be done provided both parties are in agreement as to the method.
   b. Where a conduit run crosses a sewer, it shall be designed to have suitable support on each side of the sewer to limit the likelihood of transferring any direct load onto the sewer.

4. Water Lines

   Conduit should be installed as far as is practical from a water main in order to protect it from being undermined if the main breaks. Conduit that crosses over a water main shall be designed to have suitable support on each side as required to limit the likelihood of transferring any direct loads onto the main.

5. Fuel Lines

   Conduit should have sufficient separation from fuel lines to permit the use of pipe maintenance equipment. Conduit and fuel lines shall not enter the same manhole.

6. Steam Lines

   Conduit should be installed so as to limit the likelihood of detrimental heat transfer between the steam and conduit systems.

321. Excavation and Backfill

A. Trench

The bottom of the trench should be undisturbed, tamped, or relatively smooth earth. Where the excavation is in rock, the conduit should be laid on a protective layer of clean tamped backfill.

B. Quality of Backfill

All backfill should be free of materials that may damage the conduit system.

RECOMMENDATION: Backfill within 150 mm (6 in) of the conduit should be free of solid material greater than 100 mm (4 in) in maximum dimension or with sharp edges likely to damage it. The balance of backfill should be free of solid material greater than 200 mm (8 in) in maximum dimension. Backfill material should be adequately compacted.

322. Ducts and Joints

A. General

1. Duct material shall be corrosion-resistant and suitable for the intended environment.
2. Duct materials, the construction of the conduit, or both shall be designed so that a cable fault in one duct would not damage the conduit to such an extent that it would cause damage to cables in adjacent ducts.
3. The conduit system shall be designed to withstand external forces to which it may be subjected by the surface loadings set forth in Rule 323A, except that impact loading may be reduced one third for each 300 mm (12 in) of cover so no impact loading need be considered when cover is 900 mm (3 ft) or more.
4. The internal surface of the duct shall be free of sharp edges or burrs, which could damage supply cable.

cient to limit the likelihood of damage to either structure. These separations should be determined by the parties involved.

EXCEPTION: When conduit crosses a manhole, vault, or subway tunnel roof, it may be supported directly on the roof with the concurrence of all parties involved.

2. Separations Between Supply and Communication Conduit Systems

   Conduit systems to be occupied by communication conductors shall be separated from conduit systems to be used for supply systems by

   a. 75 mm (3 in) of concrete
   b. 100 mm (4 in) of masonry
   c. 300 mm (12 in) of well-tamped earth

   EXCEPTION: Lesser separations may be used where the parties concur.

3. Sewers, Sanitary and Storm

   a. If conditions require a conduit to be installed parallel to and directly over a sanitary or storm sewer, it may be done provided both parties are in agreement as to the method.
   b. Where a conduit run crosses a sewer, it shall be designed to have suitable support on each side of the sewer to limit the likelihood of transferring any direct load onto the sewer.

4. Water Lines

   Conduit should be installed as far as is practical from a water main in order to protect it from being undermined if the main breaks. Conduit that crosses over a water main shall be designed to have suitable support on each side as required to limit the likelihood of transferring any direct loads onto the main.

5. Fuel Lines

   Conduit should have sufficient separation from fuel lines to permit the use of pipe maintenance equipment. Conduit and fuel lines shall not enter the same manhole.

6. Steam Lines

   Conduit should be installed so as to limit the likelihood of detrimental heat transfer between the steam and conduit systems.

321. Excavation and Backfill

A. Trench

The bottom of the trench should be undisturbed, tamped, or relatively smooth earth. Where the excavation is in rock, the conduit should be laid on a protective layer of clean tamped backfill.

B. Quality of Backfill

All backfill should be free of materials that may damage the conduit system.

RECOMMENDATION: Backfill within 150 mm (6 in) of the conduit should be free of solid material greater than 100 mm (4 in) in maximum dimension or with sharp edges likely to damage it. The balance of backfill should be free of solid material greater than 200 mm (8 in) in maximum dimension. Backfill material should be adequately compacted.

322. Ducts and Joints

A. General

1. Duct material shall be corrosion-resistant and suitable for the intended environment.
2. Duct materials, the construction of the conduit, or both shall be designed so that a cable fault in one duct would not damage the conduit to such an extent that it would cause damage to cables in adjacent ducts.
3. The conduit system shall be designed to withstand external forces to which it may be subjected by the surface loadings set forth in Rule 323A, except that impact loading may be reduced one third for each 300 mm (12 in) of cover so no impact loading need be considered when cover is 900 mm (3 ft) or more.
4. The internal surface of the duct shall be free of sharp edges or burrs, which could damage supply cable.

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reports, for example, that almost 63 percent of its pole inventory is jointly owned,[60] while, in the same proceeding, Niagara Mohawk Power Company reported that 58 percent of its pole inventory was jointly owned[61]. Financial statements of the Southern California Joint Pole Committee indicate that telephone companies hold approximately 50 percent of pole units[62]. Although proportions may vary by region or state, informed opinion of industry experts generally assign about 45 percent of poles to telephone companies. Note that both telephone companies and power companies may lease space on poles solely owned by the other.

While the responsibility for a pole may be joint, it is typically not equal. Because a power company commonly needs to use a larger amount of the space on the pole to ensure safe separation between its conductors that carry currents of different voltages (e.g., 440 volt conductors versus 220 volt conductors) and between its wires and the wires of low voltage users, the power company is typically responsible for a larger portion of pole cost than a telephone company.

Because of the prevalence of joint ownership, sharing, and leasing arrangements, it is unusual for a telephone company to use poles that are not also used by a power company. ILEC structure costs are further reduced by the presence of other attachers in the low voltage space. Perhaps the best example is cable TV. Rather than install their own facilities, CATV companies generally have leased low voltage space on poles owned by the utilities. Thus, the ILECs have been able to recover a portion of the costs of their own aerial facilities through pole attachment rental fees paid by the CATV companies. The proportion of ILEC aerial structure costs recoverable through pole attachment fees is now likely to increase still further as new service providers enter the telecommunications market.

As noted above, the other, most obvious reason for assigning a share of aerial structure costs as low as 25 percent to the ILEC is the way that the space is used on a pole. HM 5.0 assumes that ILECs install the most commonly placed pole used for joint use, a 40 foot, Class 4 pole.[63] Of the usable space on such a pole, roughly half is used by the power company which has greater needs for intercable separation. That leaves the remaining half to be shared by low voltage users, including CATV companies and competing telecommunications providers.

Thus, a) because ILECs generally already bear well less than half of aerial structure costs; b) because ILECs now face increased opportunities and incentives to recover aerial facilities costs from competing local service providers; c) because new facilities-based entrants will be obliged to use ILEC-owned structure to install their own networks; and, d) because the Telecommunications Act requires ILECs to provide nondiscriminatory access to structure as a means of promoting local competition, on a forward-looking basis, it is extremely reasonable to expect that ILECs will need, on average, to bear as little as 25 percent of the total cost of aerial structure.

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[60] New York Telephone's Response to Interrogatory of January 22, 1997, Case 95-C-0341: Pole Attachments, State of New York Public Service Commission, January 27, 1997.

[61] Direct Panel Testimony of Richard Wolf, Clay T. Whitehead, Donald Fiscella, David Peacock and Dr. Miles Bidwell on Behalf of the Electric Utilities, Case 95-C-0341: Pole Attachments, State of New York Public Service Commission, January 27, 1997. These experts also predicted that sharing of poles among six attachers would not be uncommon.

[62] " Statement of Joint Pole Units and Annual Pole Unit Changes by Regular Members", Monthly Financial Statements of the Southern California Joint Pole Committee, October, 1996.

[63] Opinion of engineering team. Also, "The Commission {FCC} found that 'the most commonly used poles are 35 and 40 feet high, ...'" {FCC CS Docket No. 97-98 NPRM dtd 3/14/97 pg. 6, and 47 C.F.R. § 1.1402(c). A pole's "class" refers to the diameter of the pole, with lower numbers representing larger diameter poles.

APPENDIX B

Structure Shares Assigned to Incumbent Local Telephone Companies

B.1. Overview

Due to their legacy as rate-of-return regulated monopolies, LECs and other utilities have heretofore had little incentive to share their outside plant structure with other users. To share would have simply reduced the "ratebase" upon which their regulated returns were computed. But today and going forward, LECs and other utilities face far stronger economic and institutional incentives to share outside plant structure whenever it is technically feasible. There are two main reasons. First, because utilities are now more likely to either face competition or to be regulated on the basis of their prices (e.g., price caps) rather than their costs (e.g., ratebase), a LEC's own economic incentive is to share use of its investment in outside plant structure. Such arrangements permit the LEC to save substantially on its outside plant costs by spreading these costs across other utilities or users. Second, many localities now strongly encourage joint pole usage or trenching operations for conduit and buried facilities as a means of minimizing the unsightliness and/or right-of-way congestion occasioned by multiple poles, or disruptions associated with multiple trenching activities.

Because of these economic and legal incentives, not only has structure sharing recently become more common, but its incidence is likely to accelerate in the future – especially given the Federal Telecommunications Act's requirements for nondiscriminatory access to structure at economic prices.

The degree to which a LEC can benefit from structure sharing arrangements varies with the type of facility under consideration. Sharing opportunities are most limited for multiple use of the actual conduits (e.g., PVC pipe) through which cables are pulled that comprise a portion of underground structure. Because of safety concerns, excess ILEC capacity within a conduit that carries telephone cables can generally be shared only with other low-voltage users, such as cable companies, other telecommunications companies, or with municipalities or private network operators. Although the introduction of fiber optic technology has resulted in slimmer cables that have freed up extra space within existing conduits, and thus enlarged actual sharing opportunities, the Hatfield Model does not assume that conduit is shared because as a forward-looking model of efficient supply, it assumes that a LEC will not overbuild its conduit so as to carry excess capacity available for sharing.

Trenching costs of conduit, however, account for most of the costs associated with underground facilities – and LECs can readily share these costs with other telecommunications companies, cable companies, electric, gas or water utilities, particularly when new construction is involved. Increased CATV penetration rates and accelerated facilities based entry by CLECs into local telecommunications markets will expand further future opportunities for underground structure sharing. In addition, in high density urban areas, use of existing underground conduit is a much more economic alternative than excavating established streets and other paved areas.

Sharing of trenches used for buried cable is already the norm, especially in new housing subdivisions. In the typical case, power companies, cable companies and LECs simply place their facilities in a common trench, and share equally in the costs of trenching, backfilling and surface repair. Gas, water and sewer companies may also occupy the trench in some localities. Economic and regulatory factors are likely to increase further incentives for LECs to schedule and perform joint trenching operations in an efficient manner.

Aerial facilities offer the most extensive opportunities for sharing. The practice of sharing poles through joint ownership or monthly lease arrangements is already widespread. Indeed, the typical pole carries the facilities of at least three potential users – power companies, telephone companies and cable companies. Power companies and LECs typically share the ownership of poles through either cross-lease or

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2.4. POLES AND CONDUIT

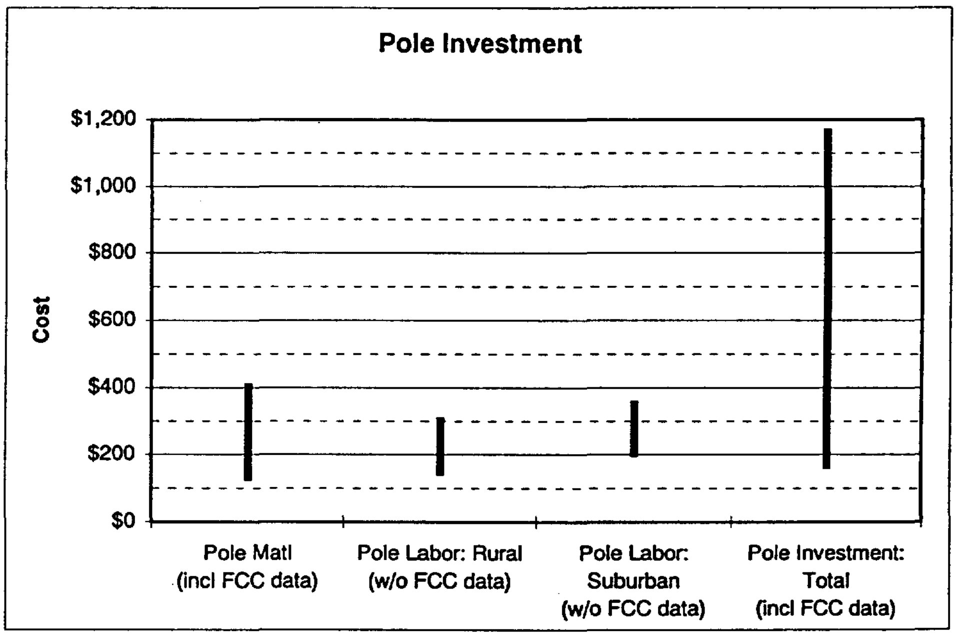
2.4.1. Pole Investment

Definition: The installed cost of a 40-foot Class 4 treated southern pine utility pole.

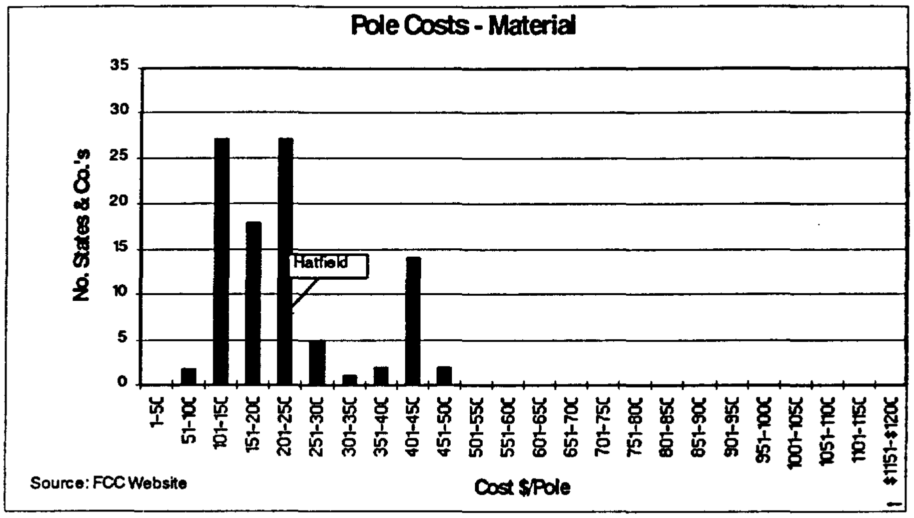
Default Values:

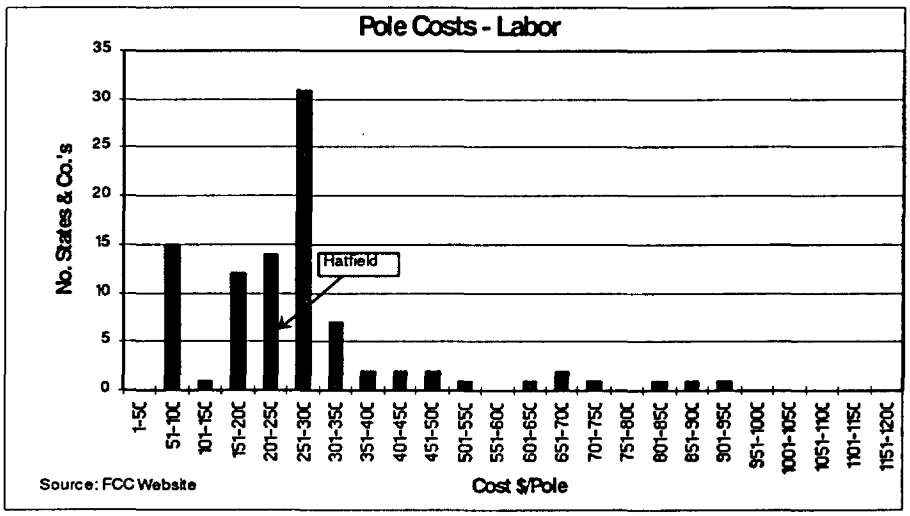
Pole Investment	
Materials	$201
Labor	$216
Total	*$417*

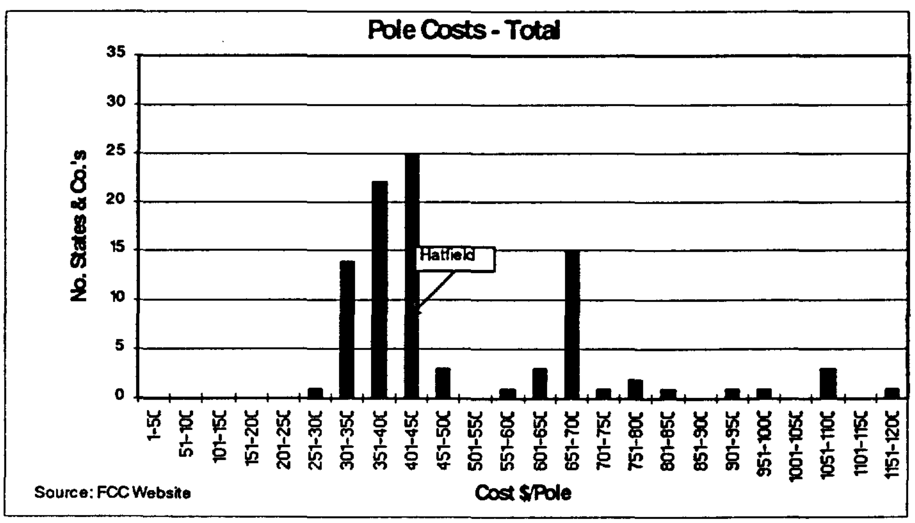
Support: Pole investment is a function of the material and labor costs of placing a pole. Costs include periodic down-guys and anchors. Utility poles can be purchased and installed by employees of ILECs, but are frequently placed by contractors. Several sources revealed the following information on prices.



Pole data has also been recently filed by large telephone companies with the FCC. A compilation of that information is shown below:


Pole Costs - Material
No. States & Co.'s
0
5
10
15
20
25
30
35
Hatfield
1-5C
51-10C
101-15C
151-20C
201-25C
251-30C
301-35C
351-40C
401-45C
451-50C
501-55C
551-60C
601-65C
651-70C
701-75C
751-80C
801-85C
851-90C
901-95C
951-100C
1001-105C
1051-110C
1101-115C
$1151-$120C
Cost $/Pole
Source: FCC Website


Pole Costs - Labor
No. States & Co.'s
0
5
10
15
20
25
30
35
Hatfield
1-5C
51-10C
101-15C
151-20C
201-25C
251-30C
301-35C
351-40C
401-45C
451-50C
501-55C
551-60C
601-65C
651-70C
701-75C
751-80C
801-85C
851-90C
901-95C
951-100C
1001-105C
1051-110C
1101-115C
1151-120C
Cost $/Pole
Source: FCC Website


Pole Costs - Total
No. States & Co.'s
0
5
10
15
20
25
30
35
Hatfield
1-5C
51-10C
101-15C
151-20C
201-25C
251-30C
301-35C
351-40C
401-45C
451-50C
501-55C
551-60C
601-65C
651-70C
701-75C
751-80C
801-85C
851-90C
901-95C
951-100C
1001-105C
1051-110C
1101-115C
1151-120C
Cost $/Pole
Source: FCC Website

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The exempt material load on direct labor includes ancillary material not considered by FCC Part 32 as a unit of plant. That includes items such as downguys and anchors that are already included in the pole placement labor cost. Outside plant engineering experts have concluded that a typical anchor plus anchor rod material investment is $45, and the typical guy material investment is $10. Also, one anchor and downguy per 1,000 feet would be typical. Therefore the embedded anchor and guy exempt material loading included in the default value of $216 is approximately $8.25 - $13.75 per pole.

The steel strand run between poles is likewise an exempt material item, charged to the aerial cable account. The cost of steel strand is not included in the cost of poles; it is included in the installed cost of aerial cable.

2.4.2. Buried Copper Cable Sheath Multiplier (feeder and distribution)

Definition: The additional cost of the filling compound used in buried cable to protect the cable from moisture, expressed as a multiplier of the cost of non-filled cable.

Default Value:

Buried Copper Cable Sheath Multiplier	
Multiplier	1.04

Support: Filled cable is designed to minimize moisture penetration in buried plant. This factor accounts for the extra investment incurred by using more expensive cable and splicing procedures, designed specifically for buried application.

2.4.3. Conduit Material Investment per Foot

Definition: Material cost per foot of 4" PVC pipe.

Default Values:

Material cost per foot of duct for 4" PVC	
4" PVC	$0.60

Section 3

EXCHANGE NETWORK DESIGN

DETERMINING THE TYPE OF OUTSIDE FACILITIES DESIGN

The outside facilities engineer is responsible for determining the type of outside facilities design that will best meet the needs of the company and the area to be served. There are three basic choices:

- Aerial
- Underground
- Buried.

The engineer should evaluate the following for each type of facilities prior to proposing its construction:

- What is the Initial First Cost?
- When is reinforcement of the facility likely to be required?
- What are the potential maintenance costs and problems?
- Is the potential for service disruption more likely with one type of facility than another due to storms, dig-ups, etc.?
- Is there a governmental or company policy in place that dictates the type of facilities that must be constructed?

These considerations apply to both primary (feeder) and secondary (distribution) cables.

Although the engineer is responsible for making the decision on the type of facilities to construct, there are a variety of resources that should be used to assist in the process:

1. **The Long-Range Outside Facilities Plan** for a central office (CO) usually contains an economic analysis comparing the cost of each

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type of facility for the main and branch primary routes. Long-range proposals for these critical routes are often contained within the plan and are to be implemented when reinforcement on these routes is required.

2. **Maintenance and trouble history** for problem areas may be documented as part of the plan or may be available from other sources.
3. **Governmental or company policies** on the type of facilities required in given areas are usually well documented and generally available to the engineer.

Initial First Cost Considerations

The initial first cost can be defined as the cost to build the job without considering future costs or benefits. The decision to propose one type of facility over another is often influenced by existing conditions, primarily because existing conditions influence initial first costs.

The initial first cost, although an important consideration because it impacts today's money, should not be the only consideration. Evaluation of the remaining considerations may indicate a low initial first cost — but excessive future costs — either due to future reinforcement requirements or excessive maintenance costs. Consider the following:

1. If there is an existing structure, such as a pole line, the initial first cost of an aerial cable will be far less expensive compared to an underground cable requiring the construction of a conduit structure. However, consider this same situation with the following additional information:
   a. The long-range plans for the area propose the placement of conduit and underground cable. All aerial cables and poles are to be removed when the conduit system is built.
   b. In addition to the initial first cost of the aerial cable, consideration must also be given to advancing the conduit structure so that the new cable can be placed underground. This eliminates the cost of placing a short-term aerial cable, and the associated

rearrangements of the facilities that would be served by this cable, in favor of advancing the conduit structure.

2. If there are both an existing pole line and an underground conduit structure, then the initial first cost of each type of facility, although still a factor, has less impact. Other factors become more critical, such as:
   a. Is it intended to maintain both aerial and underground facilities in the area?
   b. Is the proposed cable being placed to serve customers in the area of the pole line or is it for requirements further out the route? If it is for requirements further out the route, then the underground structure should be used, saving the remaining pole line positions for the local distribution.
3. If there are no existing facilities in an area, then the initial first cost along with future reinforcement requirements becomes more critical. An area that is expected to have low growth may be more conducive to aerial or buried facilities than an area with high growth. High-growth areas will likely require more cable facilities to meet the demands. These needs are best met with underground facilities where the number of ducts in the structure has been sized to accommodate the anticipated demand.

Future Reinforcement Requirements

Consideration must always be given to the next requirement that will affect an area currently being evaluated for relief. A job built today must not eliminate future alternatives; rather, it should be constructed considering the next relief requirement. Consider the following:

1. If a pole line has been designed to have four usable pole positions for telephone facilities, and a proposed job will use the last position, then the engineer must consider alternatives:
   a. Can the existing job be changed to accommodate the removal of an existing aerial cable? For example: Increase the proposed cable size to permit the removal of a smaller existing cable,

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resulting in a spare pole position available for another future aerial cable placement.

Note: When a cable is removed specifically to recover its pole position or the underground conduit that it occupies so that the space is available for future use (deferring structure reinforcement), it is referred to as "mining a cable."

b. If it is not possible to recover a pole position, should the next job be to build conduit and place underground cable?

c. Should the next job propose buried cable?

2. If it is proposed to bury a cable, then consideration must be given to:

   a. How long will the facility last?

   b. How many cables can ultimately be buried in the area?

   c. If demand increases, how will that impact the existing buried facilities as well as the long-range plans for providing facilities to the area?

   d. If the right-of-way is congested, how difficult will it be to place a conduit with the buried cable?

The point to remember when proposing any job is to consider how it impacts the next job as well as the long-range plans for the area.

Maintenance Cost Considerations

The ongoing maintenance costs associated with a particular type of outside facilities construction must be evaluated before deciding to continue to reinforce with the same type of facilities. Consider the following:

1. Existing aerial cables may experience some or all of the following, making it advantageous to consider another type of construction:

   a. In heavily wooded areas, lengthy service disruptions may result due to fallen trees.

   b. Excessive maintenance problems are sometimes experienced due to squirrels or other rodents causing sheath damage or building nests in splice cases.

   c. In areas where high winds are known to be a problem, wind-whipping of the cables causes them to wrap around themselves resulting in mechanical damage to the cable sheath.

   d. In areas where roadways exist, extensive damage to poles and cables can result from automobile accidents.

   e. In areas prone to lightning, damage to poles, cables, and hardware can result.

2. An area with a high water table may cause underground or buried facilities to deteriorate at an accelerated rate. In most cases, this problem can be alleviated through the use of filled cables or by maintaining proper air pressure on the cables. Air pressure systems increase maintenance costs, however, as continuous monitoring is required to identify leaks that will cause a decrease in the air pressure and ultimately permit water to enter the cables and splice cases.

Potential Service Disruptions

The consideration of potential service disruptions differs from maintenance considerations in that the former tend to be man-made versus acts of nature. The most common service disruptions are:

1. **Dig-ups** — For example, contractors working in areas without first having existing underground or buried facilities located often dig up the cables of other utilities. In the worst cases, the result is temporary loss of service for the customers served by the facility. It is possible, however, to dig up a cable and only damage the sheath of the cable or break the duct. In these cases, permanent repairs can be made without disrupting service. However, this type of situation causes unscheduled repair work and time required to repair the damage.

2. **Sheath or cable damage** — This damage can result from other construction activities, such as placing signs, posts, or fences. In these situations, objects can be driven down into the cable, causing service disruption and the need for repairs.

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If another buried cable is proposed in such an area, consideration should be given to:

1. Choosing another location less susceptible to construction activity
2. Increasing the depth of the proposed buried cable
3. Placing additional buried cable markers warning individuals of the presence of buried cable.

If it is decided to place underground or buried facilities, consideration must be given to locating the facility in an area least likely to be subject to potential service disruptions.

Governmental or Company Policy

There are often governmental or company policies in place that preclude any decision that the engineer may make:

1. There may be a government or company policy dictating underground or buried facilities in certain size residential housing developments.
2. There may be requirements along certain types of roadways. Major highways often require the construction of underground or buried facilities for safety as well as aesthetic reasons.

Most policies that dictate type of construction are common knowledge throughout the telephone industry. Requirements are usually well documented and generally available to the engineer.

COPPER CABLE—PRIMARY (FEEDER) DESIGN

Basic Strategies

Spare primary facilities should be apportioned along an entire primary route to defer cable relief as long as possible. This is accomplished by dividing the primary route into secondary system (distribution) areas during the Long-Range Outside Plant Planning process. Spare facilities should then be allocated along the route based on the transmission limitations of each secondary system area. Relief intervals (2 to 5 years) can then be established for various cross sections of the primary route.

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the user, is implemented by placing a ceiling on the per-line investments computed in the Distribution module (i.e., NID, drop, terminal and splice, distribution cable and structure, SAI, and DLC RT) that would be replaced by the wireless system.[46]

The optional cap calculation considers the cost of two different wireless systems: a "point-point" system serving customers on a one-one basis, and a "broadcast" system serving a number of customers from a shared base station. The point-point cost is assumed to be a fixed amount per line served; the broadcast system cost is structured as a fixed base station cost serving up to a given maximum number of customers, with the cost of the base station distributed among the number of customers that use it, plus a per-line cost of the radio terminal equipment at each customers' premises. Generally, the broadcast system is more expensive than the point-point system for a few lines in a serving area, but less expensive if the system is loaded to a substantial portion of its maximum capacity. The Model compares the cost of the two wireless systems to each other for a given serving area, then compares the cost of the lower-cost system to the wireline cost. If the most economical wireless system's cost is lower, the Model zeroes out the cost of the wireline distribution components for that serving area, and substitutes the cost of the wireless distribution system, while retaining the feeder portion of the wireline network.

6.3.5. Determination of Feeder Technology

Because it must calculate all of the outside plant distances, to determine the kind of road cable required, the Distribution Module also determines whether copper or fiber feeder and subfeeder are utilized for a given serving area. If fiber feeder and subfeeder are used, these extend from the wire center to the main cluster centroid. The subfeeder either terminates at a DLC RT and adjacent SAI at the centroid, or is extended via "connecting cables" to two or more DLC RTs and adjacent SAIs located to ensure the remaining distribution cable lengths do not exceed the user-adjustable maximum analog copper length.. In all cases, copper distribution cable is used to link SAIs to customer premises. The decision whether to use fiber feeder depends on whether any of the following conditions are met.

a) The total feeder and subfeeder distance from the wire center to the main cluster centroid is greater than the user-adjustable Copper Feeder Max Distance value, whose default is 9,000 ft.

b) A life-cycle cost analysis of fiber versus copper feeder on the route shows that fiber is more economical.

[46] It is assumed that the cost of the remote terminal electronics for the fiber feeder facilities serving the wireless radio sites would be included in the wireless system cost.

customer location in a first order outlier is less than a user-adjustable distance parameter whose default value is 18,000 feet, the road cable carries an ordinary analog voice signal, and is called "subscriber road cable." If the farthest customer in an outlier is more than the default distance from the main cluster, or the outlier is a higher order outlier, the cable carries a digital T1 format signal to a remote T1 terminal at the centroid of the outlier, and is served by "T1 road cable." From the T1 RT, copper cables carrying analog signals extend the remainder of the way to the customer locations within the outlier.

A T1 road cable contains copper pairs, and supports T1 signals used to provide digital connections between the fiber DLC remote terminals located at the centroid of the main cluster and subsidiary remote T1 terminals located at the centroid of each outlier cluster. The model assumes conventional T1 transmission with a user-adjustable 32 dB repeater spacing.

In HM 5.0, the cables serving subscribers from the remote terminals are assumed to be different than those that carry the T1 signals to the remote terminals. The total investment calculated for the T1 system includes the cost of the T1 interfaces in the main cluster's DLC remote terminal.

6.3.3. Customer Drop Arrangement

No matter whether a customer is located in a main cluster or outlier cluster, the distribution arrangement at the customer's premises is similar. At a point close to the customer's location, a splice and block terminal are installed to connect a drop cable containing several wire pairs from the distribution cable to an aerial or buried drop to the NID located on the wall of the premises.

6.3.4. Investment Cap to Reflect Potential Wireless Technologies

As requested in the FCC's FNPRM, the HM 5.0 permits the specification of a user-adjustable cap on the model's relevant wireline investments to reflect potentially more economical wireless distribution technologies.[45] In the HM 5.0, this cap, if invoked by the user, is implemented by placing a ceiling on the per-line investments computed in the Distribution module (i.e., NID, drop, terminal and splice, distribution cable and structure, SAI, and DLC RT) that would be replaced by the wireless system.[46]

The optional cap calculation considers the cost of two different wireless systems: a "point-point" system serving customers on a one-one basis, and a "broadcast" system serving a number of customers from a shared base station. The point-point cost is assumed to be a fixed amount per line served; the broadcast system cost is structured as a

[45] It is unclear whether such systems exist, whether their costs can be modeled accurately across all demographic and terrain situations, and whether these systems can meet the FCC's criteria for supported universal service.

[46] It is assumed that the cost of the remote terminal electronics for the fiber feeder facilities serving the wireless radio sites would be included in the wireless system cost.

2.3 CABLE AND RISER INVESTMENT

2.3.1. Distribution Cable Sizes

Definition: Cable sizes used for distribution cable variables (in pairs).

Default Values:

Cable Sizes
2400
1800
1200
900
600
400
200
100
50
25
12
6

Support: Distribution plant connects feeder plant, normally terminated at a Serving Area Interface (SAI), to the customer's block terminal. "Distribution network design requires more distribution pairs than feeder pairs, so distribution cables are more numerous, but smaller in cross section, than feeder cables."[3] The Hatfield Model default values represent the array of distribution cable sizes assumed to be available for placement in the network. Although three additional sizes of distribution cable (2100 pair, 1500 pair, and 300 pair cable) can be used, the industry has largely abandoned use of those sizes in favor of reduced, simplified inventory.

2.3.2. Distribution Cable, Cost per Foot

Definition: The cost per foot of copper distribution cable, as a function of cable size, including the costs of engineering, installation, and delivery, as well as the cable material itself.

[3] Bellcore, *Telecommunications Transmission Engineering*, 1990, p. 91.

Default Values:

Copper Distribution Cable, $/foot	
Cable Size	Cost/foot (including engineering, installation, delivery and material)
2400	$20.00
1800	$16.00
1200	$12.00
900	$10.00
600	$7.75
400	$6.00
200	$4.25
100	$2.50
50	$1.63
25	$1.19
12	$0.76
6	$0.63

Support: These costs reflect the use of 24-gauge copper distribution cable for cable sizes below 400 pairs, and 26-gauge copper distribution cable for cable sizes of 400 pairs and larger. Although 24-gauge copper is not required for transmission requirements within 18,000 feet of a digital central office with a 1,500 ohm limit, or a GR-303 integrated digital loop carrier system with a 1,500 ohm limit, a heavier gauge of copper is used in smaller cable sizes to prevent damage from craft handling wires in distribution terminals and pedestals. For cables of 400 pairs and larger, splices are normally enclosed in splice cases, and are not subject to wire handling problems.

Cable below 400 Pairs: Outside plant planning engineers commonly assume that the cost of cable material can be represented as an a + bx straight line graph. In fact, Bellcore Planning tools, EFRAP I, EFRAP II, and LEIS:PLAN have the engineer develop such an a + bx equation to represent the cost of cable. As technology, manufacturing methods, and competition have advanced, the price of cable has been reduced. While in the past, the cost of copper cable was typically ($0.50 + $0.01 per pair) per foot, current costs are typically ($0.30 + $0.007 per pair) per foot.

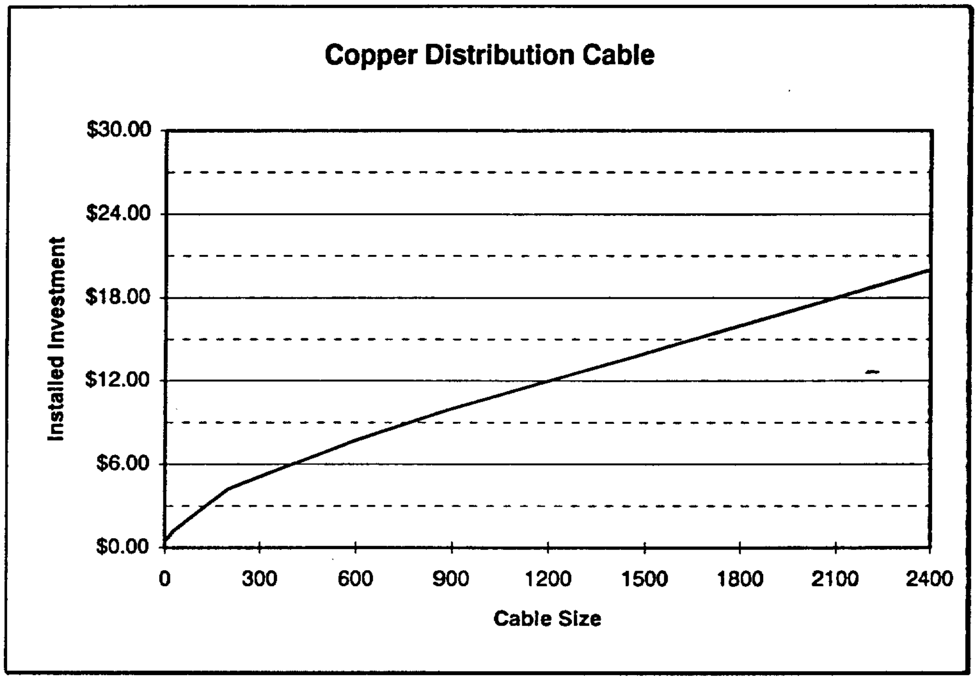
In the opinion of expert outside plant engineers whose experience includes writing and administering hundreds of outside plant "estimate cases" (large undertakings), material represents approximately 40% of the total installed cost. This is a widely used rule of thumb among outside plant engineers. Such expert opinions were also used to determine that the average engineering content for installed copper cable is 15% of the installed cost. The remaining 45% represents direct labor for placing and splicing cable, exclusive of the cost of splicing block terminals into the cable.[4]

Cable of 400 Pairs and Larger: As copper cable sizes become larger, engineering cost is based more and more on sheath feet, rather than cable size. The same is true for cable placing and splice set-up. Therefore

[4] The formula would produce a material price of $0.38/ft. for 12 pair 24 gauge cable, and $0.34/ft. for 6 pair 24 gauge cable. An actual quote for materials was obtained at $0.18/ft. for 12 pair 24 gauge cable, and $0.12/ft. for 6 pair 24 gauge cable. The significant difference in material cost is perceived to be the result of the very small quantity of sheath required for 12 and 6 pair cables. Therefore, the formula generated material price was reduced by $0.20 and $0.22 for 12 and 6 pair cables respectively, but the engineering and labor components were retained at original formula levels, since neither would be affected by the reduction in material price.

the linear relationship between the number of copper pairs and installed cost is somewhat reduced. A review of many installed cable costs around the country were used by the engineering team to estimate the installed cost of copper cable for sizes of 400 pairs and larger.

The following chart represents the values used in the model.



2.3.3. Riser Cable Size and Cost per Foot

Definition: The cost per foot of copper riser cable (cable inside high-rise buildings), as a function of cable size, including the costs of engineering, installation, and delivery, as well as the cable material itself.

Default Values:

Riser Cable, $/foot	
Cable Size	Cost/foot (including engineering, installation, delivery and material)
2400	$25.00
1800	$20.00
1200	$15.00
900	$12.50
600	$10.00
400	$7.50
200	$5.30
100	$3.15
50	$2.05
25	$1.50
12	$0.95
6	$0.80

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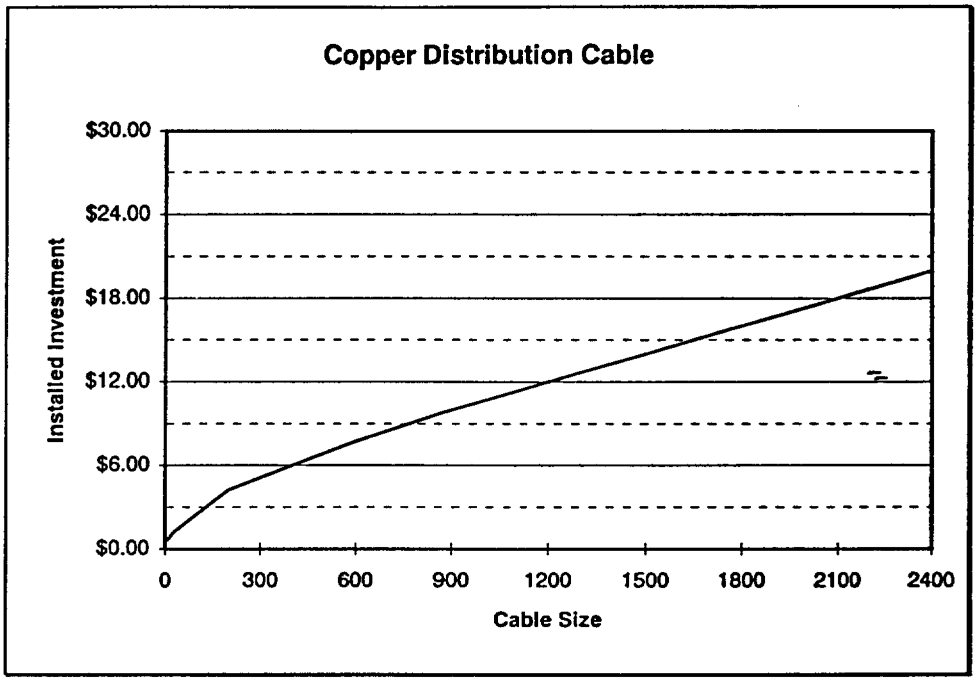
the linear relationship between the number of copper pairs and installed cost is somewhat reduced. A review of many installed cable costs around the country were used by the engineering team to estimate the installed cost of copper cable for sizes of 400 pairs and larger.

The following chart represents the values used in the model.



2.3.3. Riser Cable Size and Cost per Foot

Definition: The cost per foot of copper riser cable (cable inside high-rise buildings), as a function of cable size, including the costs of engineering, installation, and delivery, as well as the cable material itself.

Default Values:

Riser Cable $/foot	
Cable Size	Cost/foot (including engineering, installation, delivery and material)
2400	$25.00
1800	$20.00
1200	$15.00
900	$12.50
600	$10.00
400	$7.50
200	$5.30
100	$3.15
50	$2.05
25	$1.50
12	$0.95
6	$0.80

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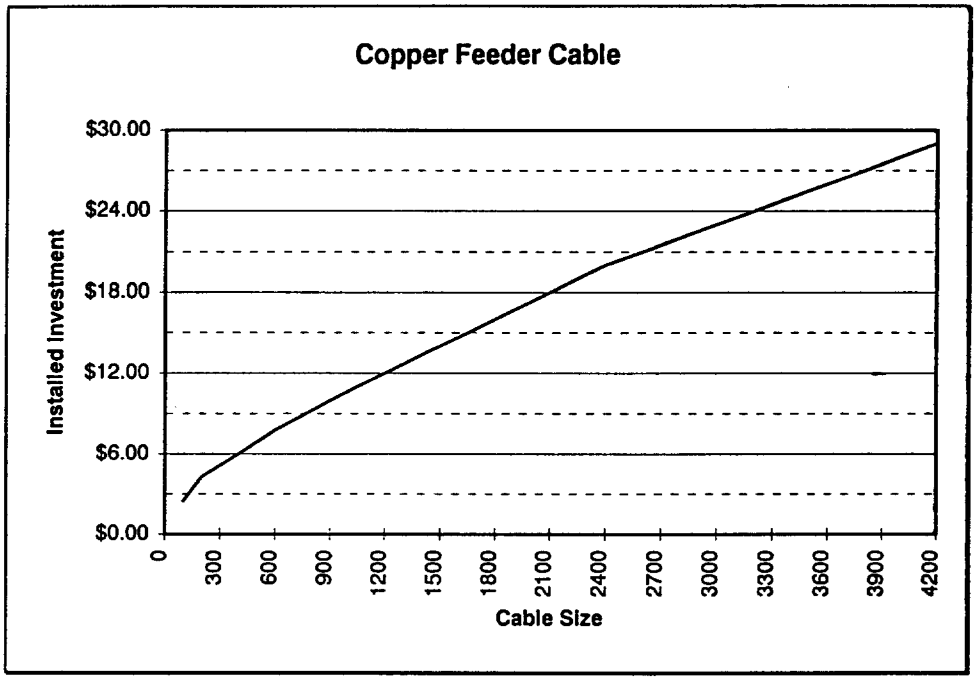
The following chart represents the default values used in the Model.



__Copper Investment per Pair-Foot:__
At the point in the model where a decision is required regarding copper vs. fiber feeder, it is not possible to determine how many copper pairs will be aggregated along each tapered section of the feeder route. Therefore a design assumption is required to determine how much of the fixed cost of the copper cable placement and sheath cost is distributed over the number of copper feeder pairs deployed. This is approximately $0.0075 per copper pair foot in the model.

3.4.2. Fiber Feeder Cable: Cost per Foot, Cost per Strand - Foot

Definition: The cost per foot ($/foot) and per strand-foot of fiber feeder cable, as a function of cable size, including the costs of engineering, installation, and delivery, as well as the cable material itself. The fiber investment per strand-foot is used in estimating comparative life-cycle costs for copper and fiber feeder.

<u>Distribution Cable Investment (NVHIP 2.3)</u>

REQUEST NO. 52	**Provide copies of all questionnaires, and respective responses, sent to vendors, contractors, and any other party used in calculating the copper distribution cable investment input values.**
RESPONSE	The copper distribution cable investment input values employed in the HAI Model are based on the expert opinion of a team of engineers with extensive experience. Questionnaires were not sent to vendors, contractors, nor any other party to determine the copper distribution cable investment input values.

REQUEST NO. 53	**To the extent that the copper distribution cable investment input values were based on copies of billings, work orders, etc., provide such documents, and the reasoning substantiating the modeler's utilization of such documents.**
RESPONSE	The copper distribution cable investment input values employed in the HAI Model are based on the expert opinion of a team of engineers with extensive experience. The values were not based on copies of billings, work orders, etc.

REQUEST NO. 54 **Provide documentation which substantiates the use of the equation used to develop the material cable costs for cable sizes less than 400 pair (material cost = $0.30 + $0.007 x cable size), referenced on page 20 of the inputs portfolio.**

RESPONSE The use of the equation material cost = $0.30 + $0.007 x cable size in number of pairs was explained in the HAI Model Inputs Portfolio as based on extensive experience by members of the engineering team supporting the HAI Model. That information is reproduced below for ease of review.

Cable below 400 Pairs: Outside plant planning engineers commonly assume that the cost of cable material can be represented as an a + bx straight line graph. In fact, Bellcore Planning tools, EFRAP I, EFRAP II, and LEIS:PLAN have the engineer develop such an a + bx equation to represent the cost of cable. As technology, manufacturing methods, and competition have advanced, the price of cable has been reduced. While in the past, the cost of copper cable was typically ($0.50 + $0.01 per pair) per foot, current costs are typically ($0.30 + $0.007 per pair) per foot.

In the opinion of expert outside plant engineers whose experience includes writing and administering hundreds of outside plant "estimate cases" (large undertakings), material represents approximately 40% of the total installed cost. This is a widely used rule of thumb among outside plant engineers. Such expert opinions were also used to determine that the average engineering content for installed copper cable is 15% of the installed cost. The remaining 45% represents direct labor for placing and splicing cable, exclusive of the cost of splicing block terminals into the cable.[12]

As stated in the HIP, the values are not based on documentation, but on experience. In addition, information received, under protective order, from a number of ILECs around the country was examined and validated these values.

[12] The formula would produce a material price of $0.38/ft. for 12 pair 24 gauge cable, and $0.34/ft. for 6 pair 24 gauge cable. An actual quote for materials was obtained at $0.18/ft. for 12 pair 24 gauge cable, and $0.12/ft. for 6 pair 24 gauge cable. The significant difference in material cost is perceived to be the result of the very small quantity of sheath required for 12 and 6 pair cables. Therefore, the formula generated material price was reduced by $0.20 and $0.22 for 12 and 6 pair cables respectively, but the engineering and labor components were retained at original formula levels, since neither would be affected by the reduction in material price.

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Default Values:

SAI Investment		
SAI Size	Indoor SAI	Outdoor SAI
7200	$9,656	$10,000
5400	$7,392	$8,200
3600	$4,928	$6,000
2400	$3,352	$4,300
1800	$2,464	$3,400
1200	$1,776	$2,400
900	$1,232	$1,900
600	$888	$1,400
400	$592	$1,000
200	$296	$600
100	$148	$350
50	$98	$250

Support: Indoor Serving Area Interfaces are used in buildings, and consist of simple terminations, or punch down blocks, and lightning protection where required. Equipment is normally mounted on a plywood backboard in common space. Outdoor Serving Area Interfaces are more expensive, requiring steel cabinets that protect the cross connection terminations from the direct effects of water. Both indoor and outdoor SAI investments are a function of the total number of pairs, both Feeder and Distribution, that the SAI terminates.

The total number of pairs terminated in the SAI is computed as follows. a) The number of Feeder Pair terminations provided is equal to 1.5 times the number of households plus the number of business, special access, and public lines required. b) The number of Distribution Pair terminations provided is equal to 2.0 time the number of households plus the number of business, special access, and public lines required.

Indoor SAI investments include the cost of over-voltage protection. Costs for that protection are assumed to be based on splicing protector equipment on feeder pairs at a cost of $200 per 100 pair protector. SAIs with fewer than 200 feeder pairs are priced accordingly at $50 per 25 pair protector.

Prices are the opinion of a group of engineering experts.

LIPS

TW CONCORP

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CUSTOMER'S ORDER NO. Lipjy					DATE 2/13 19 98			
NAME Telecon Visions.								
STREET 11 OSBORNE RD.								
CITY & STATE Garden City NY 11428								
SOLD BY	CASH	C.O.D.	CHARGE	ON ACCT.	MDSE. RET'D	PAID OUT	LP	
			N					

QUANTITY	DESCRIPTION	PRICE	AMOUNT	
1	VT0081466	58/6	58	00
1	VBL066M150	5/0	5	00
1	VBRA89B	1/0	1	00
1	SMNS66MCYCH19	2/0	2	00
			66	—
	VISA	TAX	5	45
		TOTAL	71	45

01019 RECEIVED BY [signature]

Technician Punch-down tool

Cross Connect Wire - Missing

Splice Case Missing

Technicn punchdo

66 Blo

Bracket

orange Cover

Protection - Not included here
Claims it is included based on 300 pr. splice.
Section 2.9 - p.42

6

NRC #	Alabama - NRC Elements	Total Cost	
6	POTS / ISDN BRI - Install - UNE - Loop	$ 1.90	with overhead
		$ 1.72	without overhead

SERVICE ORDER PROCESS / NON-RECURRING TYPE MATRIX

1	2	3	4	5	6	7	8	9
ID No.	Process Flow / Activity	Step	System or Action	Work Center	A Probability (%)	B Time (minutes)	C Rate ($/hour)	D = (A x B x C) / 60 Cost w/out Overhead ($)
1	*Pre Order Steps*							
2	CLEC customer contact	Pre-Order	CLEC Customer Service Representative		NA	-		
4	ILEC gateway requests address data from Administrative Information System and CSR	Pre-Order	Premis, ALOC, BOSS, CRIS		100.0%	-	R	$ -
5	ILEC gateway formats and returns address, CSR, and appointment data to CLEC	Pre-Order	WFA/FORCE, ACTIVIEW		100.0%	-	R	$ -
6	*Ordering Steps*							
7	CLEC customer service representative inputs LSR information into LOS	Order	ACTIVIEW		NA			
8	ILEC gateway receives, validates and logs LSR, returns FOC, and passes LSR to SOG	Order	ILEC gateway, STAREP, DOE		100.0%	-	R	$ -
11	*Provisioning Processing Steps*							
13	SOP sends request to SOAC	Provisioning	SOP		100.0%	-	R	$ -
14	SOAC analyzes order, generates assignment requests for OSP, COE, IOF, etc.	Provisioning	SOAC		100.0%	-	R	$ -
16	LFACS makes OSP assignments, e.g., cable and pair	Provisioning	LFACS		100.0%	-	R	$ -
18	COE and CFA assignments are made	Provisioning	SWITCH		100.0%	-	R	$ -
20	SOAC receives COE, OSP, IOF, etc.	Provisioning	SOAC		100.0%	-	R	$ -
30	SOAC delivers equipment and facility information to NSDB	Provisioning	NSDB		60.0%	-	R	$ -
32	NSDB downloads assignments to OPS/INE	Provisioning	OPS / INE		60.0%	-	R	$ -
34	OPS/INE delivers Cross Connect and equipment provisioning message to INE	Provisioning	OPS / INE		60.0%	-	R	$ -
39	WFA/C updates NSDB	Provisioning	OPS / INE		60.0%	-	R	$ -
45	*Pull and Analyze Order Steps*							
46	Pull and analyze order: FCC; (copper%)	Provisioning	ILEC manual activity	FCC	40.0%	2.50	$ 36.64	$ 0.61
53	*Travel Time Steps*							
54	Travel time to the central office. CO Unstaffed, # Orders per Trip, Copper	Provisioning	ILEC manual activity	FCC	2.0%	20.00	$ 36.64	$ 0.24
69	*Element Type Detail Steps*							
73	Install cross connect from MDF to CFA appearance	Provisioning	ILEC manual activity	FCC	40.0%	1.00	$ 36.64	$ 0.24
75	Conduct continuity test (check dial tone and ANI)	Provisioning	ILEC manual activity	FCC	40.0%	0.25	$ 36.64	$ 0.06
77	CLEC MLT test and or ISTF test	Provisioning	CLEC MLT or ISTF		NA			
81	Install DSO TSI at RT (CPU time)	Provisioning	CPU Time		60.0%	-	R	$ -
189	*Fall Out Steps*							
193	Fall Out: RMAs forwarded to PAWS for reconciliation	Provisioning	CPU Time		2.0%	-	R	$ -
194	Fall Out: Pull and analyze order: LAC	Provisioning	ILEC manual activity	LAC	2.0%	2.50	$ 33.87	$ 0.03
195	Fall Out: Clear jeopardy: LAC	Provisioning	ILEC manual activity	LAC	2.0%	15.00	$ 33.87	$ 0.17
200	*Close Order Steps*							
201	Close order: FCC Copper%	Provisioning	ILEC manual activity	FCC	40.0%	1.50	$ 36.64	$ 0.37
209	*Close Order Provisioning Steps*							
210	SOAC updates SOP	Provisioning	SOP		100.0%	-	R	$ -
211	SOP updates WFA, NSDB, LMOS, BOSS, CRIS, etc	Provisioning	SOP		100.0%	-	R	$ -
213	SOP completes LSR	Provisioning	SOP		100.0%	-	R	$ -
214	ILEC gateway notifies CLEC of completed order	Provisioning	ILEC gateway		NA			
216	*End of Process Steps*							

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Distribution Pole Spacing	
Density Zone	Spacing
0-5	250
5-100	250
100-200	200
200-650	200
650-850	175
850-2,550	175
2,550-5,000	150
5,000-10,000	N/A
10,000+	N/A

Note: HM 5.0 assumes Aerial Cable in the two most dense zones are Block and Building Cable, not support on poles.

Support: Distances between poles are longer in more rural areas for a several reasons. Poles are usually placed on property boundaries, and at each side of road intersections (unless cable is run below the road surface in conduit). Property boundaries tend to be farther apart in less dense areas, and road intersections are also farther apart.

Depending on the weight of the cable, and the generally accepted guideline that sag should not exceed 10 feet at mid-span, while still maintaining appropriate clearances as designated by the National Electric Safety Code, very long spans between poles may be achieved. This length may be as great as 1,500 feet using heavy gauge strand and very light cable, or may be shorter for heavier cables.[9] In practice, much shorter span distances are employed, usually 400 feet or less.

"...where conditions permit, open wire spans can approach 400 feet in length with practical assurance that the lines will withstand any combination of weather condition. Longer spans mean savings in construction costs and a net reduction in over-all plant investment, including fewer poles to buy, smaller quantity of pole hardware required, and less construction time. The use of long spans also means a reduction in maintenance expense."[10]

[9] Bellcore, *Clearance for Aerial Cable and Guys in Light, Medium and Heavy Loading Areas, (BR 627-070-015), Issue 1*, 1987.
see also, Bellcore, *Clearances for Aerial Plant, (BR 918-117-090), Issue 5*, 1987.
see also, Bellcore, *Long Span Construction (BR 627-370-XXX)*, date unk.

[10] Lee, Frank E., *Outside Plant, abc of the Telephone Series, Volume 4*, abc TeleTraining, Inc., Geneva, IL, 1987, p. 41.